VOL. LXXVIII. PART IV

Transactions

of

The Chartered Surveyors' Institution

SESSION 1945–46.

AT THE ORDINARY GENERAL MEETING

Held at the Chartered Surveyors' Institution on Monday, 3rd December, 1945.

Mr. E. B. GILLETT (*President*) in the Chair.

NEW MEMBERS.

The following new members were received by the President prior to the meeting and signed the Register :—

Professional Associates :

CROSER, ERNEST KEITH. KNIGHT, EDMUND DENIS.

NEW HONORARY MEMBER.

On the motion of the President on behalf of the Council, Colonel S. J. Worsley, D.S.O., M.C., M.A., Principal of the College of Estate Management, was unanimously elected an Honorary Member of the Institution.

The following PAPER was read by MR. JOHN W. LAING (of Messrs. John Laing & Sons, Ltd., Building and Engineering Contractors).

MODERN METHODS OF HOUSE CONSTRUCTION.

By John W. Laing, F.I.O.B.

I am glad to address members of the Chartered Surveyors' Institution on this subject as we have always considered you to be the technical auditors of the building industry. People build dream houses, but the wise surveyor shows to what extent these dreams can be made practical and brought to earth.

Almost all forms of practical construction fall under the heading brick, timber, concrete and steel; aluminium is also being adopted. We shall also consider prefabricated houses as compared with those built on the site.

Essential factors in a house are cost, accommodation, comfort—which includes health—durability, appearance and surroundings.

Cost.—Speaking generally, the cost of a *brick* house is the same as timber, though the latter may be slightly less. Occasionally we have been asked to tender alternatively for timber and brick. In some cases the brick house is as cheap as the timber, and in other cases we have known the timber to be 10 per cent. cheaper than the brick house.

If the building industry is normal, with bricks plentiful and with a good supply of industrious bricklayers, a *concrete* house costs slightly more—say 5 per cent. more—than brick. But when bricks and bricklayers are in short supply the cost of a brick house is increased: at such times the concrete house is a little cheaper than brick.

A *steel* house costs about 10 per cent. more than a brick house. There is still uncertainty with regard to the cost of an aluminium house, though I think we may take it that it will be decidedly dearer than steel.

All comparative costs are subject to fluctuations due to local conditions or variations in the supply of materials; also the different forms of concrete or steel constructions vary in price.

Prefabricated houses are dearer than houses built on the site. This is rather disappointing, but is in accordance with our own experience, and, when visiting America just before the war, we found that six or so of the large firms which had started mass production of prefabricated houses discovered they could not on the whole compete successfully with houses traditionally built. That was in a country where everything lends itself to prefabrication, where there is a plentiful supply of timber, which is a most suitable material for this type of construction and mass production in a factory, and where also the site built house is handicapped by higher rates of wages paid to the site operatives. The same high rates of wages would, no doubt, apply in the factory, but it would be expected that machinery would reduce the hours considerably, thus giving the factory produced article an advantage. Further, our experience in Britain with regard to prefabricated temporary houses has confirmed that prefabricating a house, or sections of a house, and transporting to the site and erecting there, increases the cost.

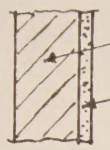
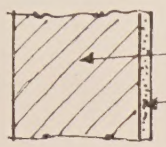
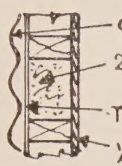
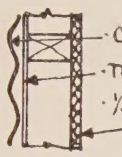
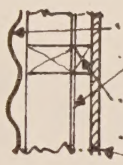
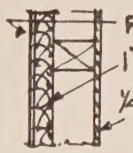
We now turn to the matter of *accommodation*. All methods of construction are about equal in this respect, for although certain houses, such as steel, cannot give the variety of accommodation provided by the traditional house, they have an advantage in that as there are fewer types, the designs of these are well considered.

On the question of *comfort*, when non-traditional houses were built 25 years ago, the promoters were proceeding with new forms of construction and working somewhat blindly in a new sphere, whereas in the present day all new forms of construction are guided and shepherded by the Building Section of the Department of Scientific Research, which leads the promoters safely past many of the pitfalls. By using the new methods and materials that are available, and by adopting the recommendations of the department, a high standard of comfort is provided by the non-traditional house—in some cases an even higher standard than the traditional.

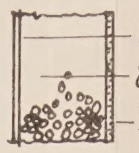
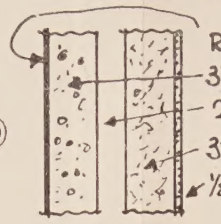
I should here like to express the indebtedness of the building industry to

THERMAL INSULATION

TRANSMITTANCE & RESISTANCE OF VARIOUS TYPES OF WALL ETC.

CONSTRUCTION & FINISH	TRANSMITTANCE IN B.T.U. = U. ↓	RESISTANCE ↓
1.  4½" BRICKWORK. ¾" PLASTER.	.53.	1.91.
2.  9" BRICKWORK. ¾" PLASTER.	.35	2.81.
3. 4½" BRICKWORK 2" CAVITY. 4½" BRICKWORK ¾" PLASTER.	.34 to .30.	3.00 to 3.33.
4.  CORR. STEEL SHEETING. 2" SAWDUST & SHAVINGS THIN FELT OR PAPER. ¼" ASBESTOS.	.17.	5.87.
5. Do. BUT ¾" PLYWOOD LINING.	.16	5.96.
6. Do. BUT ⅜" PLASTER BOARD LINING.	.16.	6.05.
7.  CORR. STEEL SHEETING. THIN FELT OR PAPER. ½" FIBRE BOARD.	.32.	3.13.
8.  CORR. STEEL SHEETING. ALUMINIUM FOIL. ¾" BATTENS. ¼" ASBESTOS.	.24.	4.21.
9. Do. BUT ¾" PLYWOOD LINING.	.23.	4.30.
10. Do. BUT ½" FIBRE BOARD DO	.18.	5.44.
11.  FELT. 1" WOODWOOL SLABS. ¼" ASBESTOS.	.28.	3.61.
12. Do. BUT ¾" PLYWOOD LINING.	.27.	3.71.
13. Do. BUT ⅜" PLASTER BOARD. DO.	.26	3.85.
14. Do. BUT ½" FIBRE BOARD. Do.	.21.	4.84.

CONSTRUCTION & FINISH	TRANSMITTANCE IN B.T.U. = U. ↓	RESISTANCE ↓
15. CORR. ASBESTOS SHEETING ¼" ASBESTOS.	.50.	1.99.
16. Do. BUT ½" FIBRE BOARD.	.31.	3.22.
17. CORR. ASBESTOS SHEETING THIN FELT OR PAPER. 2" SAWDUST & SHAVINGS ¼" ASBESTOS.	.16.	5.92.
18. Do. BUT 3/16" PLYWOOD LINING.	.16.	6.01.
19. Do. BUT ⅜" PLASTER BOARD "	.16.	6.10.
20. CORR. ASBESTOS SHEETING ALUMINIUM FOIL ¾" BATTENS. ¼" ASBESTOS SHEETING	.23.	4.26.
21. Do. BUT 3/16" PLYWOOD LINING.	.23.	4.35.
22. Do. BUT ½" FIBRE BOARD do.	.18.	5.49.
23. Do. BUT ⅜" PLASTER BOARD do.	.22.	4.44.
24. ⅛" R.C. FINISH. 3½" BALLAST CONCRETE. ½" PLASTER.	.70.	1.43.
25. Do. 6" CONCRETE.	.56.	1.78.
26. 3½" CLINKER CONCRETE. ½" PLASTER	.58.	1.73.

CONSTRUCTION & FINISH	TRANSMITTANCE IN B.T.U. = U. ↓	RESISTANCE ↓
27.  ¼" RENDER 8" NO-FINES CONCRETE. ½" PLASTER	.42.	2.39.
28. Do. 12" NO-FINES CONCRETE.	.32	3.11.
"EASIFORM" 29.  R.C. FINISH 3½" BALLAST CONC. 2" CAVITY. 3½" CLINKER " ⅛" PLASTER.	.29	3.4.

FLOORS.

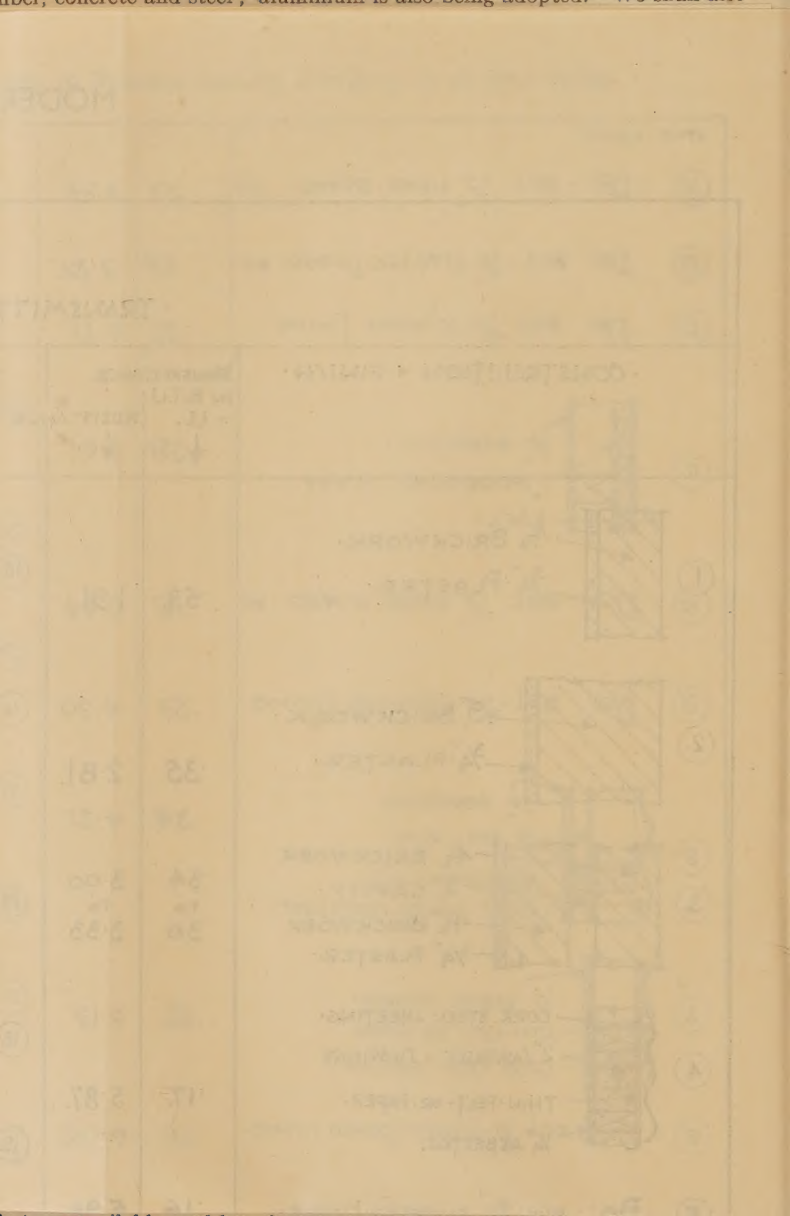
	TRADITIONAL HOLLOW FLOOR. 1" T&G. BOARDS JOISTS OPEN SPACE BELOW.	
30.	THROUGH VENTILATED COVERED LINO.	.35.
31.	WITHOUT LINO.	.40.
	VENTILATED ONE WALL ONLY.	
32.	WITH LINO.	.25.
33.	WITHOUT LINO.	.30.
34.	6" CONCRETE & WOOD BLOCKS.	.15.

ROOFS.

	TRADITIONAL: CEILING L&P. ROOF SPACE	
35.	TILES OR SLATES & FELT.	.42.
36.	DO. INSULATED WITH 1½" SAWDUST.	.17.
	FLAT ROOF.	
37.	¾" TARMAC 2 LAYERS FELT. ¾" BOARDING 1" GLASS WOOL. JOISTS ⅜" PLASTER BOARD.	.17.

Nov. 1945.

Paper read at an Ordinary General Meeting of The Chartered Surveyors' Institution, 12 Great George Street, Westminster, S.W.1, on 3rd December, 1945.



the department for its valuable assistance in advancing knowledge regarding the use of both old and new materials.

Concerning *durability*, it is necessary that any form of construction shall be enduring and easily maintained, and it is well to recognise that some forms of construction which may be suitable for occupation by elderly people, are not ideal for a family of boisterous children. A lining of thin board, such as plasterboard, fibreboard, or asbestos sheeting, with a cavity behind, does not compare for permanent reliability with a strong plaster finish on a substantial brick or concrete wall. Also, in the matter of fire resistance, fibreboard needs to be kept well painted to make it reasonably resistant, and even then it does not compare with traditional construction. With regard to vermin infestation, a plaster finish on a substantial brick or concrete wall is less liable to vermin infestation than thin boards with a cavity behind.

As regards *appearance*, I think we are agreed that in house building nothing surpasses a hand-made clay brick, although the latter is closely followed by many forms of machine-made rustic brick. Some forms of concrete houses, finished with a Tyrolean roughcast, are almost, if not quite, equal to brick in appearance.

Owing to rigidity of design, the steel and aluminium houses will have a less attractive appearance, but the houses will be architecturally designed, and finished in pleasing colours, so that if the site planning is good, metal houses should be of very satisfactory appearance.

All forms of house construction can result in either beautiful or ugly dwellings and care is certainly needed in design and layout. An attractive appearance being one of the essentials, it is fortunate that this can be obtained by careful, thoughtful designing and planning by trained and experienced house architects at practically little extra cost.

The question of *surroundings* is important. A good plan and a good lay-out ensure lasting value. Perhaps I might instance this by mentioning a house built by my grandfather 98 years ago. It was sold by our family 40 years after it was built, for £150, and we observed that it was re-sold some years ago for £850. In that case there was a combination of good planning, equal to any modern planning, substantial construction, and a setting amidst beautiful surroundings. This emphasises the advantage of a good house plan and a good district lay-out plan. One can hardly imagine any circumstance that would cause housing in Letchworth, for example, to depreciate in value.

At the present time the shortage of skilled men and of certain materials, and the probability that within a short time there will be unemployment among unskilled men, and in certain industries, such as engineering, makes it necessary that alternatives to the traditional forms of construction should be used.

Walls.—Prior to going into more detailed explanation of the different methods of construction I would refer you to the attached chart,(1) showing in the first column the thermal transmittance of different walls, referred to as U.

I would draw your attention in the first place to item No. 3, the 11″ cavity wall, which has a U value of ·3 to ·34. We will use this as a basis for comparison with others.

Item No. 4—a timber frame, covered externally with felt and corrugated iron, covered internally with asbestos cement sheeting, and the space filled with sawdust and shavings—is a surprisingly efficient and economical form of construction, having a U value of ·17. Item No. 8 constructed as No. 4,

(1) Enclosed with this Journal in loose leaf form.

but with a sheet of aluminium foil, instead of sawdust, has a U value of ·24. Item No. 10, which is the same construction as No. 8, but lined with fibreboard, instead of ¼″ asbestos, has a U value of ·18.

Flooring.—The traditional floor consisting of t. and g. boarding nailed to joists, with a ventilation space underneath, is at present expensive and the heat losses are considerable. If well ventilated, it has a U value of ·40. A flooring therefore recommended by the Housing Manual is a layer of concrete, wood fillets thoroughly creosoted, and boarding, which is economical and warm.

The flooring we most strongly recommend, however, is concrete and wood blocks. This has a U value of ·15. Unfortunately it costs about £10 per house more than the aforementioned floor, but it avoids the necessity for linoleum and is safe from the danger of dry rot.

Other floor coverings could be pitch mastic or Granwood. Pitch mastic on concrete is the cheapest of floors. Granwood is rather dearer than wood blocks.

Roofs.—The traditional roof, consisting of plaster ceiling, roof space, and a covering of tiles or slates, with felt underneath, has a heat loss of U ·42, but if there is an insulation of 1½″ of sawdust, or 1″ of glass wool above the plaster ceiling, the heat loss is reduced to U ·17.

A flat roof consisting of plaster board, glass wool, joists, ¾″ boarding, two layers of felt and ¾″ of tar macadam, also has a heat loss of U ·17.

It may be of interest to compare the flat roof cost with the traditional. We have frequently made up estimates of the comparative cost, and taking everything into consideration, allowing for a similar insulation of both, and for the cost of gables of a pitched roof, the cost of the tiled pitched roof is no greater than that of a flat roof. Most of us would consider that the appearance of the tiled roof is very much better.

Party Walls.—To avoid the transmission of sound, party walls should have a cavity, whether the walls are of brick or concrete ; but a 9″ solid brick wall, or a 12″ No-fines concrete wall is still accepted without a cavity.

Partitions.—The three most practical forms of partition of which we are aware are :—

1. Clinker or foamed slag concrete slabs, plastered.
2. A studding with plasterboard each side,insulated where necessary by means of felt, or similar, for sound resistance between rooms.
3. A number of layers of plasterboard joined together, making a total thickness of about 1½″ to 2″.

There is little difference in cost, but in the first it is necessary to use plasterers, who may be in short supply, and in the latter to use plasterboard which *is* in short supply.

We now contrast the traditional house with the insulated house, calculating the floor at U ·15 in contrast with U ·4, the walls at U ·2 in contrast with U ·3, and the roof at U ·17 in contrast with U ·42.

I quote the following from Mr. Maurice Bland, the Heating Engineer, and express my indebtedness to him for the calculation.

" It is interesting to consider what fuel saving is effected by improving the insulation qualities of the walls, floor, and ceilings of a 900 f.s. house, the type occupied by a small wage earner.

" Firstly, assuming that this is built in the traditional manner, with 11″

cavity walls, plaster ceilings and hollow ventilated floor. For every 100 heat units dissipated, the losses can be considered approximately as follows :—

Floor	18		
Walls	26		
Ceilings	21		
	—	65	
Windows, doors and by airchange		35	
		—	100

" Now, if the house is built with a solid floor and wood blocks, insulated walls, and if the ceilings are covered with 2" sawdust, the heat losses are reduced to :

Floor	7·5		
Walls	17		
Ceiling	10·5		
	—		35

" There is no alteration in the losses from the windows, doors, and by airchange.

" The heat losses have been reduced by 30 per cent., and assuming that the same internal temperatures are obtained, there should be a saving of 30 per cent. of the fuel and electricity used for warming the house.

" If 3 tons of fuel are consumed per annum for warming and water heating, when a separate small domestic hot water supply boiler is used, it is reasonable to assume that half of this is used for warming the house, that is 1½ tons, and that this is supplemented by, say, 300 units of electricity used at different times for warming bedrooms.

" A saving of 30 per cent. of these approximate amounts is :—

	£	*s.*	*d.*
1½ tons of fuel at £4 per ton (30 per cent. on £6)	1	16	0
300 units of electricity at 1*d.* per unit (30 per cent. on the 25*s.*)...		7	6
Per annum	£2	3	6

This amount can be apportioned as follows :—

	£	*s.*	*d.*
By floor		15	3
By walls		13	0
By ceilings		15	3
	£2	3	6

" It may now be said that the traditional method of warming a house of this type and heating the water, consists of an open fire in the living room and a small hot water supply boiler in the kitchen. Although the thermal efficiency of these units is not high, they have several merits. The maintenance cost is low, the simple boiler is not easily damaged and its operation is understood by most people. The fire in the living room need never be lit in the summer months."

The annual saving of £2 3*s.* 6*d.*, calculated on a 60-years' life for the house, at a 4 per cent. interest rate, equals a capital value of £49 4*s.* 0*d.* Of this more than one-third is saved on the floor, less than one-third on the walls, and more than one-third on the roof.

We consider that the one-third on the floor should be saved, because in every case, with the exception of a very unlevel site, it can be accomplished at very little extra cost. The one-third saved in the roof should be made use of,

as by insulating with either sawdust or glass wool, it can be accomplished at a very small extra cost. In the case of the walls, however, we do not think the insulation cost is justified, as in most cases it necessitates the use of a type of wall which would not withstand hard usage over a long period.

Heating.—Much attention has been given during recent years to the improvement of the heating system for the small type house.

We may take it that generally the most economical form of heating is by solid fuel. An essential in the use of solid fuel in future is that it shall be smokeless.

Improved fires have been designed in recent years which consume coke, and similar fuels, readily. This has been accomplished by a change in design of the fire-back, which by its depth provides that the fuel is in a great measure surrounded by heat-radiating fireclay, and this, which entails no extra cost, causes the coke to burn more easily than with the old type of fire-back.

As one looks at some of our grimy manufacturing towns and compares them with smoke-free places, one realises that a prime duty in building and manufacturing is to avoid the emission of smoke. This can be accomplished without extra cost.

The next question to consider is the comparative merits of an open, or closed fire. An open fire gives a fuel efficiency of about 15 per cent. to 25 per cent., whereas a closed fire gives an efficiency of 40 per cent. to 50 per cent. The scientists say that a much higher fuel efficiency can be effected even than the latter, and that is so, if the design and construction of the fire-place are first class and are maintained as such, and also if the stoking is given proper attention. In such circumstances the efficiency might rise as high as 60 per cent. Even on the lower figure, however, the question of the closed fire certainly merits consideration.

As against sheer economy, the open fire has the great advantage of cheerfulness and ventilation, with its resultant bracing effect on health. A reasonable compromise can be adopted in a fire which is closed when the room is not in use, and opened during the few hours when people are sitting in the room. In addition to heating rooms, it is often necessary that the fire should heat the hot water boiler.

Much attention has been given to the use of convector heating, by which means a certain amount of the heat from the living-room fire is transferred by flues to other rooms. With a closed fire this process can raise the temperature of two of the bedrooms by 10°. It must be remembered that no fire has magical powers, and in heating more hot water and also bedrooms, more fuel is required ; but apart from fuel consumption, it is a great convenience if one fire can answer a number of purposes.

As against that, however, the fire in a sitting room is only required for a certain period of the year, and some other system must then be installed to provide hot water during the period when the living room fire is not required. We have adopted three systems :—

1. An independent boiler in the kitchen, which uses solid fuel.
2. An instantaneous gas heater, such as the Ascot.
3. An electric immersion heater.

If a house is occupied by a family, using a liberal supply of hot water, the independent boiler is preferred. But if the house is occupied by those only using it for sleeping purposes and for breakfast, then the second or third alternatives are advisable.

The three systems might be compared as follows :—

1. *Solid Fuel.*—1 cwt. of coke, approximately costing 4*s*., used in an independent boiler, would provide 250 gals. of water at 140°, and in addition would provide heat in the kitchen and in the drying cupboard.

2. *Gas Heater.*—4 therms of gas, also costing about 4*s*. would provide 250 gals. of water at 140°, but would not give heating in the kitchen and in the drying cupboard.

3. *Electric Immersion Heater.*—The same amount of hot water would be provided, as in the two former, and with electricity at 1*d*. per unit would cost about 8*s*. It would provide heat in the drying cupboard, but not in the kitchen.([2])

If, however, the amount of hot water required were reduced by half, *i.e.*, 125 gals., the cost of coke heating and heating by electricity would be about equal.

As a point of interest I might mention the case of a business friend who built 170 houses without providing any system of solid fuel heating for hot water. Within a few years in each house a change over had been effected, as people could not afford any other type of heating water than by solid fuel.

To prevent loss of heat, it is essential in the modern house that the flow and return pipe from the boiler to the hot water cylinder, and also the hot water cylinder, should be thoroughly lagged.

The Government has developed an elaborate prefabricated unit, which gives effect to all the foregoing desiderata, and will have a very high standard of efficiency, but against that, it must be remembered that it restricts the planning of a house and in some cases sacrifices comfort in certain of the rooms to permit of its use. It requires consideration, therefore, whether the amount of fuel economy justifies the forfeiting of the most desirable planning, when practically the same results can be obtained by the use of the most modern types of fireplaces, and also by plumbing scientifically planned and lagged.

Alternative Methods of Construction.

Let us now refer to several of the alternative methods of construction which are being adopted, and later consider new details and materials.

Concrete constructions can be divided into two categories (*a*) those in which the walls carry the weight, and (*b*) those in which there is a concrete frame clothed outside and inside with suitable sheeting.

The following fall under category (*a*) :—

No-fines construction.—The walls in this case are of concrete, a recommended thickness of 12″. The aggregate of the concrete varies in size from ⅜″ to ¾″. Owing to the lack of all fine material, the concrete is cellular, and when coated with render and roughcast, the wall is damp-resisting. The interior is plastered. The system avoids the use of bricklayers and has been widely used in Scotland with satisfactory results.

" Easiform " construction.—This consists of an outer leaf of dense concrete, a cavity, and an inner leaf of clinker concrete. The cavity ensures that the construction is dry. Several thousands were built 25 years ago and have proved to be dry and warm. Care is required in construction, and the steel moulds need to be well made so that perfectly true walls result without using skilled men for the work. Bricklayers and plasterers are not required, but should the latter be in abundant supply they could be used for the internal finish.

There are now no patent rights in connection with either the No-fines or " Easiform " constructions.

Another interesting form of construction in this class consists of pre-cast

([2]) Reference was made to these figures in the discussion which followed the paper.

LONDIN. UNIV.

panels of vibrated concrete, each panel being of a suitable width, about 2′ 0″ or 3′ 0″, and 8′ 0″ high. As such panels were used in the building of concrete ships with good results, they will be water resisting. The internal lining consists of a non-conductor, such as clinker concrete, glass wool, or similar non-conductor, lined internally with plasterboard or other suitable material. As the units are manufactured in the factory, this system reduces site labour.

Falling under category (*b*) are various forms of concrete framework houses, clad outside with either concrete slabs or brickwork, and inside with a suitable material such as clinker concrete slabs or wood wool slabs.

An interesting form of frame construction is one in which small concrete posts, about 4″ x 2″, are erected in the same way as the wood framing of a timber house. The outside is sheeted with thin concrete slabs somewhat like timber weather boarding, and the inside is suitably lined with insulating material and plasterboard, or other like material.

As surveyors I would remind you that in using concrete for building walls for houses you are using material that has to be compared with brick. One thousand bricks—which is approximately 2 cb. yds.—used to be delivered to the site of houses in the London area, pre-war, for about 40*s*., whereas 2 cb. yds. of concrete put into the foundations of a house cost about 60*s*.(3) Therefore a clay brick is a very cheap material as compared with cement concrete. To overcome this handicap of cost of bulk material, you will observe that some methods cast the concrete into the walls, thus avoiding the labour of building. Other forms of construction pre-cast concrete in light sections and high quality, and trust to an insulating material for warmth. It is interesting to observe that the manufacturers of concrete bricks in an endeavour to get their product to compete with clay bricks have a very large frog in the brick to save materials.

The various types of *steel* houses might be classed under three headings :—

1. A frame is formed of hot rolled steel joists, or stanchions. These are all of substantial thickness.
2. A steel firm has evolved a frame, formed of 3/16th hot rolled steel, formed into a lattice work stanchion. This method still preserves the substantial character of the hot rolled steel frame work and it economises in the use of steel, but increases the amount of labour by forming the small stanchions into lattices by means of electric welding.
3. The third type has stanchions formed of sheet steel, usually 14 gauge.

All these types are treated to prevent corrosion. The framing is clad externally with various materials, in some cases 4½″ brick ; others with concrete blocks ; others with expanded metal lathing, rendered with cement and roughcast ; others with various forms of steel sheeting. One type has horizontal corrugations, which give a similar appearance to weather boarding. Others have vertical corrugations with splayed angles to the corrugations instead of round angles. These give clear vertical lines and a pleasing appearance. Whichever type of steel sheeting is used it is suitably lined with an insulating material and an internal surface such as plasterboard, which construction gives a good thermal resistance.

In the case of any frame construction, either concrete or steel, it is necessary to watch that the frame and cladding, both inside and out, are somewhat comparable with the cost of a brick cavity wall.

In conclusion, I should like to refer again to the subject of cost, for whether houses are built by individuals, or by the nation, the cost must be such as can be afforded. Our nation is planning for the building of 4,000,000 houses.

(3) Reference was later made to these figures by the proposer of the vote of thanks.

If we can save £200 on the cost of each house, the nation would be saved the cost of the American loan. Since we are now a poor nation and must work to produce everything we wish to enjoy, we should decide upon a reasonable standard for a house. Comfort, durability, appearance and surroundings are essentials that must receive due consideration, but we must also consider cost, and whether housing is provided by private enterprise, or by municipalities, whether it is built by traditional construction or by other methods, we must keenly watch each item of cost and prevent a burden of debt that would lower our standard of living.

THERMAL INSULATION OF BASIC MATERIALS.

Material.	*Thermal Conductivity per inch for 1° F. difference in Temp.= K.*	*Thermal Resistance.*	*Value of "k" for Practical Thickness.*		*Resistance.*
Asbestos cement	2·70	0·37	¼″	0·8	·09
Brick, common	5·00	0·20	4½″	1·1	·90
			9″	·55	1·80
			13½″	·37	2·70
Brick, facing	9·20	0·11	4½″	2·05	·49
Concrete :					
Gravel 1-2-4	7·00	0·14	3½″	2·00	·49
Clinker	2·80	·36	3½″	·80	1·26
No fines	5·50	·18	3½″	1·57	·63
Foamed slag	2·20	·45	3½″	·63	1·58
Cement mortar	12·00	0·08	¾″	16·00	·06
Glass wool	0·27	3·70	1″	0·27	3·70
Plaster, gypsum	3·30	0·30	½″	6·60	0·15
			¾″	4·40	0·23
Do., on metal lath			¾″	4·40	0·23
Do., on wood lath			¾″	2·50	0·40
Do., lime on wood			¾″	2·00	0·50
Plaster board			⅜″	3·73	0·27
Ruberoid roofing built up to ⅜″			⅜″	3·53	0·28
Sawdust and shavings	0·41	2·44	2″	0·21	4·88
			3″	0·14	7·32
Fibre board—Celotex	·33	3·00	½″	·66	1·50
Donnaconna	·37	2·70	½″	·74	1·35
Essex	·53	1·90	$\frac{3}{16}$″	2·83	0·35
Lloyd board	·34	2·95	$\frac{5}{16}$″	1·10	0·92
Tentest	·38	2·63	½″	·76	1·32
			⅝″	·62	1·65
Corrugated steel	Ignore conductivity of metal use surface coefficients only adding 50 per cent. for added area of corrugations.				
Wood	1·00	1·00	3″	·33	3·00
Air space over ¾″	1·10	0·91			
Surface coefficients :					
Internal	1·65	0·61			
External	6·00	0·17			
Cabot's quilt :					
9·4 lb. per cub. ft.	·316	3·16	½″	·63	1·59
			¾″	·42	2·35
13·4 lb. per cub. ft.	·341	2·93	½″	·68	1·47
			¾″	·46	2·18
Slag wool or silicate cotton	·25 to ·30	4·00 to 3·33	1″	·25 to ·30	4·00
			2″	·13 to ·15	8·00
Asbestos flexible felt			½″	·56	1·8

Mr. E. C. Harris (Member of Council) in proposing a vote of thanks to the author, said that in view of Mr. Laing's long experience in the design and construction of domestic buildings it would be difficult to find anyone more competent to discourse on the subject. It was interesting to recall that although his firm was founded in 1848, it was not until 1926 that its head-quarters were established in the metropolitan area. Mr. Laing's record since that time was a notable one. He had built 27,000 houses (although housing comprised only about one-third of the firm's work) and apart from that practical achievement, had always given unstintingly of his time and experience, by service on Government committees and other bodies, to anything which made for the betterment of the building industry. He had also been one of the foremost promoters of the Housebuilders' Registration Council which had done so much to regularise and control the standard of house building.

He had hoped their guest would have let them into a few of his secrets as to the methods which he proposed to introduce into his own post-war housing. He had in mind factory-made components which, without being mere sales-men's gadgets, would introduce desirable amenities without any undue increase of cost. Many of the promoters of prefabricated houses had shown great ingenuity in introducing fitments, labour-saving devices, warming appliances, and the like, and he believed that the wholesome competition between the promoters of prefabrication and the traditional housebuilder would be all to the good for the industry.

Although many of them would view with some alarm the prospect of the general distribution of prefabricated houses, they must recognise that the prefabricated house undoubtedly had its place in the solution of the housing problem. Analysis proved that the number of skilled man-hours on the site in prefabrication were extremely low compared with the number for a traditional house. Prefabricated houses would release the technical labour necessary for the general building programme, thus allowing a reasonable number of traditional houses to be built. There were other essential buildings as well as houses. There were factories, hospitals and schools. All this building was sadly in arrears.

With regard to the æsthetic side, the important factors were proportion, texture of materials, avoidance of monotony, and, above all, a tasteful lay-out. He was assured that the Government departments concerned were fully alive to these requirements.

Mr. Laing would forgive him if he suggested one correction. He had said that two cubic yards of bricks at pre-war prices could be delivered to the site for about 40*s*., and had compared this figure with the cost of concrete, two cubic yards at 60*s*. But it must be remembered that the concrete was mixed and placed in position, and it would be logical to compare its cost, not with loose bricks, but with built brickwork, which on the same basis of pricing would cost 108*s*. for two cubic yards.

He agreed that the capital cost of a house was a factor of national importance, but it was clear to surveyors that until either type could be put in hand in considerable quantities, first costs could not be low. Few types of prefabricated houses could be economically produced under an initial order of less than 5,000, and it was only by developing considerable acreage with traditional houses that bulk buying and the bonus system to operatives could influence the final figures. He apologised for touching on a point which might be somewhat political, but until the departments realized that they could not get low costs by letting contracts for houses in fours, sixes, dozens, or even in fifties, they would not get down to real economy in small house building.

He would carefully preserve Mr. Laing's paper for reference, and he moved that their heartiest thanks be extended to him for his contribution to an important subject.

Mr. J. W. Turner (Chairman, Junior Organization Central Committee), in seconding the vote of thanks, said that in considering the application of modern methods to housing construction at the present time houses must be divided into two categories : those to be built for owner-occupation and those

for municipalities or the State to let to tenants. Methods of construction which were quite suitable for the former type might not be suitable for the latter. Certain methods of internal construction involved a grave risk from vermin. On a municipal estate that was a serious consideration. He felt the use of wall board for internal wall lining should not be undertaken in that type of house.

On the costs of heating water, he would like to query Mr. Laing's figures for electrical heating as compared with gas. He thought gas at the present time should be taken at a considerably higher price than the 1*s.* a therm. If an efficiency for an instantaneous gas water heaters were taken as 40 per cent., the costs of gas and electricity would then be nearly equal, and with electricity there would be heat not only for the water but for the drying cupboard.

With regard to standardization, admirable though some of the fitments might be, he could not help feeling that in standardizing houses and standardizing the furniture to go in them, things were tending to go too far. Individuality began at home. Modern methods of construction should supply a greater variety of well-designed articles at a low price, not just one article at a low price.

Mr. F. R. Morrison (Fellow) said that the author had not mentioned stone, yet in parts of the West of England very practicable forms of building stone were obtainable. Was stone uneconomical?

Mr. P. J. Waldram (Fellow) thought Mr. Laing's paper was one of the most valuable papers the Institution had ever had. Could the author supply a little more information, for example, particulars of the thermal efficiencies of timber framing of the traditional type, sixteenth and seventeenth centuries? All the timber frames of which particulars were given were covered with corrugated iron or asbestos, and not very attractive. He himself had had considerable experience of timber houses, some over a hundred years old, erected with soft wood frames and cladded with ordinary weather boarding. They had proved most efficient as regards warmth.

Could the author also furnish some particulars, preferably illustrated, of the methods of plastering used in the "Easiform" houses which were described in a recent issue of *The Builder*? This work was carried out with semi-skilled or unskilled plasterers. He would also like particulars of the precautions which his firm took to avoid a superabundance of sulphur in the clinker concrete of the inner frame of the "Easiform" house.

The housing problem at the present time did not consist entirely of building new houses. There was also the repair of neglected and damaged houses. Some letters in *The Times* recently had protested against the pulling down of old houses merely because they did not satisfy the local surveyor who, of course, could not take risks. Surveyors required a great deal of knowledge about reconditioning and its possibilities. Where was that knowledge to be found? He suggested in firms like Mr. Laing's, who did not hesitate to add to their staff the most skilled architects and the best surveyors available.

Mr. J. Gordon Elsworthy (Fellow) said the author need not have apologised for emphasising the question of cost. With cost went also the question of speed. Four million houses were wanted, and the rate at which those houses were going to be produced was all important. Did not the author think that on the question of speed the concrete house of "Easiform" variety was one of the best. He had tried to recall which houses he had seen during the last twenty-five years which were the quickest to build, and he remembered a housing estate in South Wales built on the "Easiform" method about twenty-five years ago in blocks of a dozen. He thought those houses took, from start to finish, with the component parts largely

manufactured on the site, about six weeks to erect. That was the quickest he had himself encountered.

He was grateful to Mr. Laing for the most useful chart appended to the paper. It opened up a new vista for proceeding by scientific methods and not by the haphazard ones which had for so long been the characteristic of some of our building. They did not all realise what good work the Building Section of the Department of Scientific Research had done. If the costs for heat transmission or heat-resistant materials could be kept down, they would be on the road to getting a house which would last for the sixty years now recognized as the appropriate life of a house.

In speaking of heating the author had dealt, from the artistic point of view, with the ill effects of soot and smoke. From the economic point of view also smokeless fuels brought about a considerable decrease in maintenance costs.

The question of the flat roof, while being bound up with the artistic aspect, was also a matter of common sense. We build in a wet country and our ancestors wisely decided on the sloping roof, which not only fitted so well into the English landscape, but also dispersed the rainfall quickly.

With regard to the aluminium house, the latest figures showed that it had jumped in price from somewhere about £900 to £1,365. He hoped that on every ground they would leave the aluminium house alone, not only on account of cost, but also appearance and comfort.

Mr. W. F. THORPE (Fellow) had seen one of Mr. Laing's concrete houses, and although they were not out to praise any particular method, nevertheless he understood that to put up such houses would take less than six weeks.

Concrete houses were both quick to erect and were pleasing to the eye. He hoped attention would be paid to that form of construction.

He agreed with what had just been said about flat roofs. As he had seen them in some districts they were certainly not pleasing to look at, and he thought their multiplication would spoil the countryside. On the other hand some prefabricated houses in good lay-outs in tree-lined roads would be good planning.

Mr. J. D. TRUSTRAM EVE (Fellow), who supported the motion of thanks to Mr. Laing, said that he would be glad of the latter's assistance in assessing the relative merits of pre–1939 houses and the post-war houses to be erected.

There were at present only the temporary prefabricated houses to look at, but these contained a number of improvements which, in his opinion, were of great value to the occupiers. In addition to many amenities, there were the arrangements for heating the rooms and for heating water. Could Mr. Laing say how much the housewife would save in cost of fuel compared with, say, an ordinary pre-war council house.

Mr. W. H. SCANLAN (Fellow) said that surveyors were little concerned with the prefabricated temporary houses ; these had to be accepted in present circumstances, but it was to be hoped they would in due course disappear. As surveyors, they should confine themselves to the construction of the traditional brick house and the more modern concrete house.

The brick house, apart from certain minor technical faults, due to defective workmanship, was entirely satisfactory. Modern concrete presented difficulties which they must appreciate. It was important before using it to take the advice of an engineer who understood concrete, or to go to the Building Section of the Department of Scientific Research. He recently saw a concrete-frame building from which in three months the plaster had disappeared. With concrete one could get an uneven torque in a building which would cause almost irreparable settlement. It was important to keep their minds very clear on those two forms of construction.

The author had made a comparison between brick and concrete. He suggested, with all due respect to Mr. Laing and to Mr. Harris, who had spoken on the same subject, that the comparison was a bad one. They could not really be compared. The bricks were delivered on the site. In the case of concrete, it was the complete material which was deposited, but allowance must be made for shuttering.

Finally, would the author pass on to them some information about the standard materials which were being used. These standard materials need not be unsightly. They might make the appearance of a building quite satisfactory and would certainly contribute to a reduction in cost of the final structure.

Mr. JOHN W. LAING, after thanking the speakers for their kind remarks, said that to some of the questions he could not give a correct answer, but he would do his best with the others. Two speakers had mentioned the cost of brick versus that of concrete. What he meant by the comparison was this. If it cost more to put concrete into a foundation than it cost to get bricks on to the job a concrete brick could not be made as cheaply as a clay brick. If a concrete slab 4½ inches thick were being made it must cost at least as much as, or rather more than, the bricks for a 4½-inch wall. Those were some of the limitations of concrete.

One member had spoken very rightly about spoiling the planning for efficiency of plumbing. It was necessary to heed that point. Ordinary plumbing could be used if it was used scientifically, because then one got practically as high an efficiency as with a combined plumbing-heating unit, and without the sacrifice of planning. By planning and lagging the plumbing in a post-war house could also be made practically frost-proof. Someone had asked what would be the effect of using a closable fire as compared with an open fire. Approximately he thought that in a workman's house it would save 10 cwt. of fuel in a year.

[*Mr. Laing later obtained confirmation of this figure, though in practice householders would probably use the same amount of fuel and enjoy the additional comfort.*]

With regard to the " Cozy " type of stove, he was pleased to find that in almost all cases when houses had been fitted with it the tenants considered the advantages, including the saving of fuel, out-weighed the disadvantages.

Much had been said about temporary construction. He was sure they were all glad that permanent construction, whether steel, concrete or brick, was cheaper than a prefabricated temporary building.

On the question of noise between houses, the instructions given by the Building Section of the Department of Scientific Research, were invaluable. Houses built according to those instructions had afterwards been tested by experts who proved that noise was greatly reduced.

The speed of construction had figured largely in the discussion. In all forms of construction, brick, concrete and steel, the speed largely depended on organization and the supply of materials. The time taken in one case might be a month, in another six weeks, in yet another eight weeks, but there one got, he thought, the absolute extremes. As speed was dependent very largely on organization, a house should not be started until the materials were on the site.

It was also much more economical if a contractor could build steadily, say, two hundred houses, which should provide a year's work for his men. In that way he got a gradually increasing efficiency and developed the team spirit among his workers. It was an economy to build about two hundred houses in a unit.

There was one argument in favour of building concrete houses—he was pushing no one method in particular—and it was this. It would not be long, probably, before there was unemployment among unskilled men and the various methods of building concrete houses could employ unskilled labour which might otherwise be unemployed. Concrete houses, if well designed and considered, could be built as quickly and at about the same cost as the traditional house.

He was glad to hear that several speakers preferred the tiled roof. It might be thought to be old-fashioned but he, personally, felt that a roof which quickly got rid of the water and threw it well away from the walls resulted in a more care-free house than any other that he knew.

Mr. Waldram had also mentioned some houses which had been condemned and were going to be demolished, but had been rebuilt with the old materials, avoiding pulling down as far as possible.(4) The average cost of those houses—speaking generally—was below £250 a house, whereas the cost

(4) In view of space shortage, and since the point is here brought out by Mr. Laing, Mr. Waldram's previous remarks on this particular point were not reported on page 53.

if they had been demolished and entirely rebuilt would certainly have been at least £700 per house. Therefore where a new house had been bomb-damaged they should certainly try to save it if at all possible. He agreed, however, with what had been said in condemnation of large sums being spent on houses which were really obsolete—houses not properly fitted with bathroom and w.c. accommodation. It would be in the national interest that such houses should be cleared away.

Clinker concrete could be an excellent material, but it needed very great care. It was well to get samples of the clinker and test it for sulphur content and for unconsumed coal, and only use it if it reached the British Standards Specification. The Building Section of the Department of Scientific Research would advise anyone on this subject.

Mr. Waldram had asked about the timber house. Timber itself, as stated in the table of thermal insulation of basic materials, had a thermal resistance per inch of thickness of 1·00 compared with a common brick at ·20 ; but in addition to that, if a timber house were built thoughtfully, it could be one of the warmest of houses. He remembered that the Norwegian Government in his youth built about thirty experimental small buildings (each 2 metres square and in depth), some of timber, others of brick, concrete, and stone. They were kept through the winter for six months at a temperature of 60 deg., heated by electricity thermostatically controlled, and decidedly the best building of all for thermal resistance was a house with an inch boarding outside, felt next to that, sawdust and shavings in between, and ¾-inch or ½-inch matchboarding inside.

He sympathised with Mr. Morrison in his question about stone. It was a great disappointment that they had to drop the building of stone houses and adopt the brick house rough-cast. It seemed as if it could not be avoided.

Concerning the thermal values of gas and electricity, someone had suggested that the cost of gas should be calculated at 1*s* 3*d*. a therm instead of at 1*s*. He accepted that. In the London district the charge for gas varied in different localities from 1*s*. per therm to 1*s*. 6*d*. per therm. Solid fuel was the cheapest method of heating water, gas next, and electricity came third.

Someone had asked what practical improvements had resulted from all the science of the last few years. There were many valuable improvements, none of them startling in themselves, but the accumulation was impressive. They could now get, at practically no extra cost, a floor with twice the thermal resistance value of former floors. At a little extra cost they could get a roof of twice the value, and plumbing which would be practically frost-resistant at a reasonably extra cost ; as well as fires which burned smokeless fuel and emitted a much higher amount of useful heat to each lb. of fuel consumed.

He did not think they need fear standardization. He desired as much as anyone that the domestic architecture of the country should be beautiful and interesting, but standardization could be directed towards giving a good quality article at about the same price instead of a poor quality article. When it came to internal fittings there were reasonable alternatives even when standardized. For example, standardized windows varied in size and shape.

The vote of thanks was put from the Chair and carried with acclamation, and the meeting terminated.